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Shockwave Propagation and Quenching in AP/Al/HTPB Propellants at Elevated Temperatures: Mapping the Reaction Kinetics of AP/HTPB and Aluminum Under Dynamic Loading

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Dynamic shock loading experiments were performed on a series of 90wt% solids loaded AP/Al/HTPB propellants in order to study the initiation, shockwave propagation, and reaction quenching mechanisms. The AP particle size in the formulations range from 90 to 400 microns, coated by either tricalcium phosphate or ferric oxide. The goal is to determine the reaction kinetics of both the primary AP and HTPB binder reaction and the secondary combustion of the aluminum with the primary reaction products. The shock loading was performed using a standard sabot accelerated in a powder gun, and the shockwave propagation and chemical reactions monitored by in-situ manganin pressure gauges. To lower the initiation threshold of the still relatively large failure diameter of the 90wt% solids loaded propellant, we heated the propellant up to 175 C and measured the shock loading response at elevated temperatures. The analysis of the results involves the development of a reactive-flow model and global reaction kinetics to account for the propagation and quenching of the shock profile. For the 90 wt% solids loaded propellant, the fraction reacted of AP/HTPB reached 20% at 175 C before sideways release starts to quench the reaction. The results are compared to similar experiments performed on 88wt% solids loaded propellants and formulations loaded with AP from different manufacturers.

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